

TRANSLATION

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that I know well both the Japanese and English languages,
that I translated, from Japanese into English, Japanese Patent
Application No. 2001-029835, filed on February 6, 2001, and
that the attached English translation is a true and accurate
translation to the best of my knowledge and belief.

Dated: June 5, 2006

A handwritten signature in cursive script, appearing to read 'Yuko Mitsui', is written above a horizontal line.

Yuko Mitui

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SPECIFICATION

[Title of the Invention]

IMAGE FORMING APPARATUS

[What is Claimed is:]

[Claim 1]

An image forming apparatus characterized by comprising:
a recording head unit in which a plurality of recording heads are arranged in substantially the same direction as an arranging direction of recording elements such that an overlapped region is formed between the heads;

detection means for detecting a set angle and a width of the overlapped region of each of the plurality of recording heads from a predetermined test chart printed using the recording head unit;

image data distribution means for distributing image data input to each of the plurality of recording heads, in accordance with the detected width of the overlapped region between the heads; and

driving timing correction means for, when driving the recording elements of each of the plurality of recording heads in accordance with the distributed image data, correcting a driving timing of each recording element in accordance with the detected set angle.

[Claim 2]

The image forming apparatus according to claim 1, characterized by comprising notification means for, if at least one of the detected set angle and the detected width of the overlapped region of one of the plurality of recording heads exceeds a predetermined allowable range, notifying a message

demanding replacement or adjustment of the recording head.

[Claim 3]

The image forming apparatus according to claim 1, characterized in that if at least one of the plurality of recording heads is replaced or adjusted, a predetermined test chart is printed, and at least one of the set angle and the width of the overlapped region of each of the plurality of recording heads is detected again from the printed test chart.

[Claim 4]

The image forming apparatus according to claim 1, characterized in that whether input image data which corresponds to the overlapped region between the heads is a line image is determined, and, if the image data is found to be a line image, the image data is so distributed that no complementary printing is performed in the overlapped region.

[Claim 5]

The image forming apparatus according to claim 1, characterized in that a plurality of the recording head units are provided in correspondence with different color outputs.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to an image forming apparatus.

[0002]

[Prior Art]

A high-speed image forming apparatus capable of simultaneously forming images of a plurality of lines by

one-time scan by arranging a plurality of recording heads in substantially the same direction as a nozzle arranging direction such that overlapped regions are formed between the heads is conventionally known. In addition, various methods of improving image forming apparatuses with the structure described above have been proposed. For example, Jpn. Pat. Appln. KOKAI Publication No. 5-57965 discloses an image forming apparatus which eliminates density unevenness in the head overlapped regions.

[0003]

[Object of the Invention]

Unfortunately, the conventional techniques including Jpn. Pat. Appln. KOKAI Publication No. 5-57965 described above have the problem that highly accurate head alignment is necessary.

[0004]

The present invention has been made in view of the aforementioned requirement, and it is an object of the present invention to provide an image forming apparatus capable of eliminating density unevenness in the head overlapped regions only by rough head alignment.

[0005]

[Means for Achieving the Object]

In order to achieve the aforementioned object, an image forming apparatus according to a first aspect of the invention comprises: a recording head unit in which a plurality of recording heads are arranged in substantially the same direction as an arranging direction of recording elements such that an overlapped region is formed between the heads;

detection means for detecting a set angle and a width of the overlapped region of each of the plurality of recording heads from a predetermined test chart printed using the recording head unit; image data distribution means for distributing image data input to each of the plurality of recording heads, in accordance with the detected width of the overlapped region between the heads; and driving timing correction means for, when driving the recording elements of each of the plurality of recording heads in accordance with the distributed image data, correcting a driving timing of each recording element in accordance with the detected set angle.

[0006]

According to a second aspect of the invention, there is provided an image forming apparatus according to claim 1, comprising notification means for, if at least one of the detected set angle and the detected width of the overlapped region of one of the plurality of recording heads exceeds a predetermined allowable range, notifying a message demanding replacement or adjustment of the recording head.

[0007]

According to a third aspect of the invention, there is provided an image forming apparatus according to claim 1, in which if at least one of the plurality of recording heads is replaced or adjusted, a predetermined test chart is printed, and at least one of the set angle and the width of the overlapped region of each of the plurality of recording heads is detected again from the printed test chart.

[0008]

According to a fourth aspect of the invention, there is provided an image forming apparatus according to claim 1, in which whether input image data which corresponds to the overlapped region between the heads is a line image is determined, and, if the image data is found to be a line image, the image data is so distributed that no complementary printing is performed in the overlapped region.

[0009]

According to a fifth aspect of the invention, there is provided an image forming apparatus according to claim 1, in which a plurality of the recording head units are provided in correspondence with different color outputs.

[0010]

[Embodiment of the Invention]

An embodiment of the present invention will be described in detail below with reference to the accompanying drawings. FIG. 1 is a view showing an outline of a recording head unit including a plurality of recording heads of an inkjet printer to which the present invention is applied. As shown in FIG. 1, a plurality of recording heads 2-1, 2-2, ..., 2-n are arranged on a base 1 in substantially the same direction as the arranging direction of nozzles (recording elements; 2-11, 2-12, ..., 2-1(m-1), and 2-1m for the recording head 2-1) for discharging printing ink so as to have predetermined overlapped regions 3A and 3B between the heads, thereby forming one recording head unit. Reference numeral 4 denotes a recording width. A recording head unit having this arrangement records

one page on a recording medium by performing scan at least once.

[0011]

FIG. 2 is a view for explaining printing of test charts used in this embodiment. In this embodiment, test charts 5-1, 5-2, and 5-n are formed by performing printing four times by using the recording heads 2-1, 2-2, ..., 2-n, respectively. By reading and analyzing the test charts 5-1, 5-2, and 5-n, the set angles of the recording heads 2-1, 2-2, ..., 2-n and the widths of the overlapped regions 3A and 3B can be detected. The detected set angles and overlapped region widths are stored as correction data. When printing is actually performed using the recording heads 2-1, 2-2, ..., 2-n, the discharge timings of the nozzles of the plurality of recording heads 2-1, 2-2, ..., 2-n are corrected in accordance with the set angle data, and input image data to the recording heads 2-1, 2-2, ..., 2-n is distributed in accordance with the overlapped region widths.

[0012]

FIG. 3 is a block diagram showing the arrangement of an image forming apparatus according to this embodiment. Prior to an actual printing process, test charts as explained with reference to FIG. 2 are formed by driving the recording heads 2-1, 2-2, ..., 2-n on the basis of test chart data 14. The formed test charts are read by a test chart reader 19 such as a scanner, and the set angles and overlapped region widths of the recording heads 2-1, 2-2, ..., 2-n are detected by a set angle/overlapped region detector unit (detection means) 20. The detected set angles and overlapped region widths are stored

as correction data in a correction data storage unit 17.

[0013]

A message display unit (notification means) 18 displays a message which demands head replacement or adjustment if the detected set angle or overlapped region width exceeds an allowable range. If even one of the recording heads 2-1, 2-2, ..., 2-n is replaced or adjusted, a new test chart is printed, and the set angles and overlapped region widths of the recording heads 2-1, 2-2, ..., 2-n are detected again by using the printed test chart.

[0014]

In an actual printing process, an image data processor unit 10 performs image processing, e.g., converts input RGB image data into CMYK image data. A line image determinator unit 12 determines, for each overlapped region width, whether image data in the overlapped region is a line image by using the overlapped region width data stored in the correction data storage unit 17. The determination result is stored in a determination result storage unit 11. Image data subjected to the determination by the line image determinator unit 12 is binarized by a binarizer unit 13, and input to an image data distributor unit 15. The image data distributor unit 15 distributes the input image data on the basis of the line image information stored in the determination result storage unit 11 and the overlapped region width data stored in the correction data storage unit 17. This image data distribution process will be described later.

[0015]

The image data thus distributed on the basis of the overlapped regions is supplied to a discharge timing correction unit (driving timing correction means) 16. The discharge timing correction unit 16 corrects the discharge timings of the nozzles of the recording heads 2-1, 2-2, ..., 2-n on the basis of the set angle data stored in the correction data storage unit 17. The recording heads 2-1, 2-2, ..., 2-n print an image by discharging ink from the nozzles at the corrected discharge timings in accordance with the input image data.

[0016]

FIG. 4 is a flowchart of the line image determination process in the line image determinator unit 12. First, the line image determinator unit 12 determines whether or not input image data has an overlapped region (step S1). If NO in step S1, the line image determinator unit 12 terminates the line image determination process by doing nothing (step S5). If YES in step S1, the line image determinator unit 12 extracts an input image corresponding to the relevant overlapped region (step S2). Then, the line image determinator unit 12 extracts features of the extracted image data and determines whether the image data is a line image in accordance with a known method (step S3). The result of the determination of whether the image data is a line image is stored in the determination result storage unit 11 in accordance with the overlapped region (step S4). The flow then returns to step S1 to determine whether or not there is another overlapped region. If there is another overlapped region, the line image determinator unit 12

performs the processing from step S2. If there is no more overlapped region, the line image determinator unit 12 completes the line image determination process.

[0017]

FIGS. 5(A) to 5(C) are views for explaining the image distribution process in the image data distributor unit 15. As shown in FIG. 5(A), if printing is directly performed by using the recording heads 2-1 and 2-2 having some overlapped nozzles, printed images are overlapped in the overlapped region 3A by ink discharged from the overlapped nozzles. To avoid this overlapped printing, as shown in FIG. 5(B), image data is so distributed that complementary printing is performed in the overlapped region 3A by alternately driving the recording heads 2-1 and 2-2. When image data is a natural image, the overlapped region 3A is beautifully printed. However, if image data is found to be a line image, the image printed by complementary printing cannot be linear (the image is zigzagged), so no clear line image can be printed (FIG. 5(B)).

[0018]

If image data is a line image in the overlapped region 3A, therefore, this image data is so distributed that the nozzles of only one of the recording heads 2-1 and 2-2 are driven, thereby performing no complementary printing. FIG. 5(C) shows an example of an image printed by driving only the recording head 2-2 in the overlapped region 3A. In this way, a clear line image can be printed in the overlapped region 3A.

[0019]

FIG. 6 is a view showing an example in which the image

forming apparatus of this embodiment is applied to a high-speed recording apparatus capable of color printing. Reference numerals 100-1 and 100-2 denote paper feed rollers; and 101, a head fixing device in which recording heads 102-1, 102-2, and 102-3 for cyan (C), recording heads 103-1, 103-2, and 103-3 for magenta (M), recording heads for yellow (Y), and recording heads 104-1, 104-2, and 104-3 for black (K) are so arranged as to have overlapped regions between the heads.

[0020]

In the above embodiment, the set angles and the widths of overlapped regions of a plurality of recording heads are detected from test patterns printed in advance. In actual printing, input image data is distributed on the basis of the detected overlapped region widths, and the discharge timings of nozzles are corrected on the basis of the detected set angles. Therefore, density unevenness in the head overlapped regions can be eliminated only by rough head alignment.

[0021]

[Advantage of the Invention]

According to the present invention, an image forming apparatus capable of eliminating density unevenness in the head overlapped regions only by rough head alignment can be provided.

[Brief Description of the Drawings]

[FIG. 1]

A view showing an outline of a recording head unit including a plurality of recording heads to which the present invention is applied.

[FIG. 2]

A view for explaining printing of test charts used in this embodiment.

[FIG. 3]

A block diagram showing the arrangement of an image forming apparatus according to this embodiment.

[FIG. 4]

A flowchart of a line image determination process performed by a line image determinator unit 12.

[FIG. 5]

Views for explaining an image distribution process performed by an image data distributor unit 15.

[FIG. 6]

A view showing an example in which the image forming apparatus of this embodiment is applied to a high-speed recording apparatus capable of color printing.

[Explanation of Reference Symbols]

1: Base

2-1, 2-2, 2-n: Plurality of recording heads

2-11, 2-12, 2-1(m - 1), and 2-1m: Nozzles

3A, 3B: Overlapped regions

4: Recording width

5-1, 5-2, 5-3: Test charts

10: Image data processor unit

11: Determination result storage unit

12: Line image determinator unit

13: Binarizer unit

14: Test chart

- 15: Image data distributor unit
- 16: Discharge timing correction unit
- 17: Correction data storage unit
- 18: Message display unit
- 19: Test chart reader unit
- 20: Set angle/overlapped region detector unit

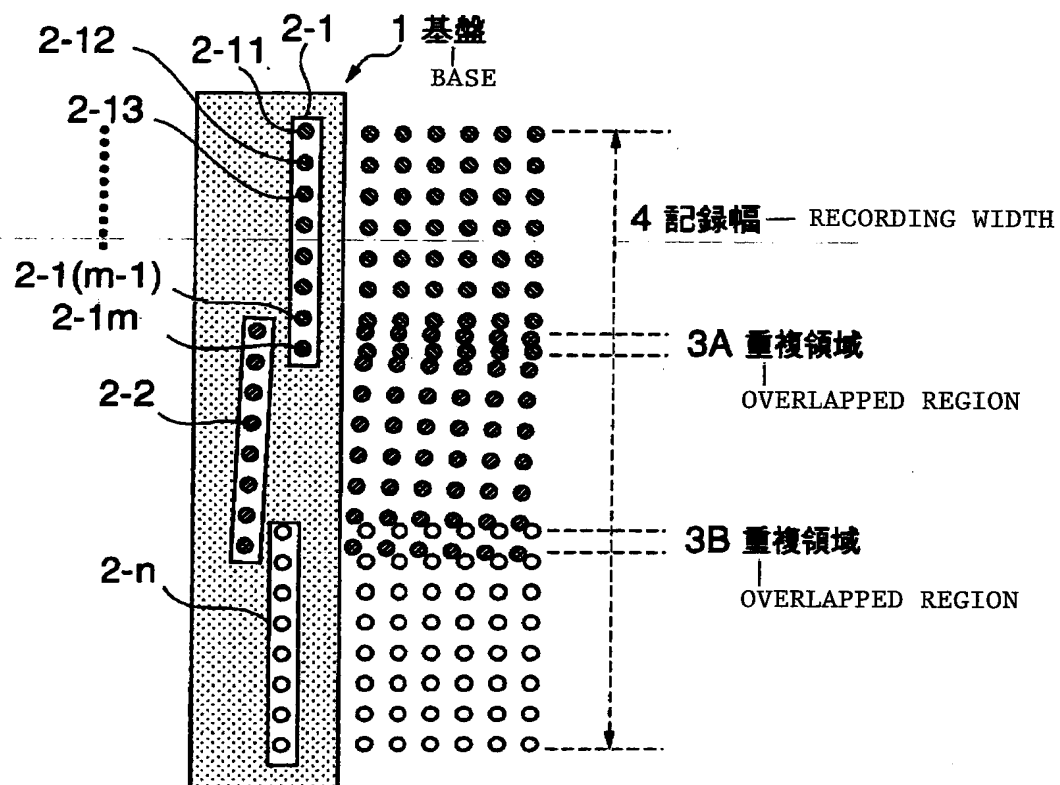
【書類名】

図面

DRAWINGS

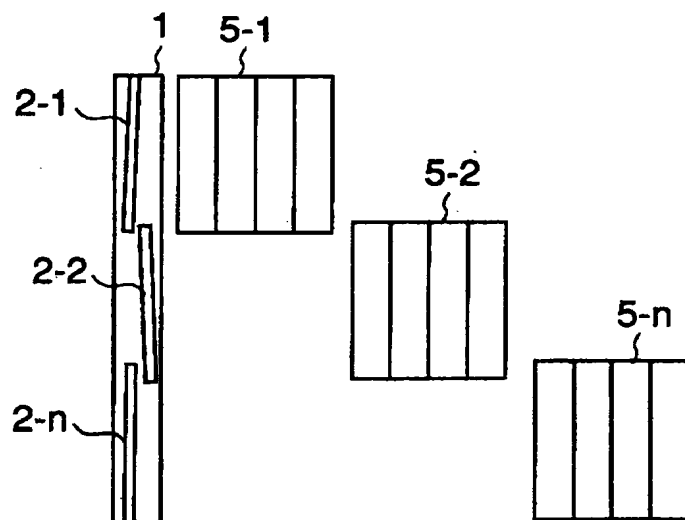
【図 1】

FIG. 1



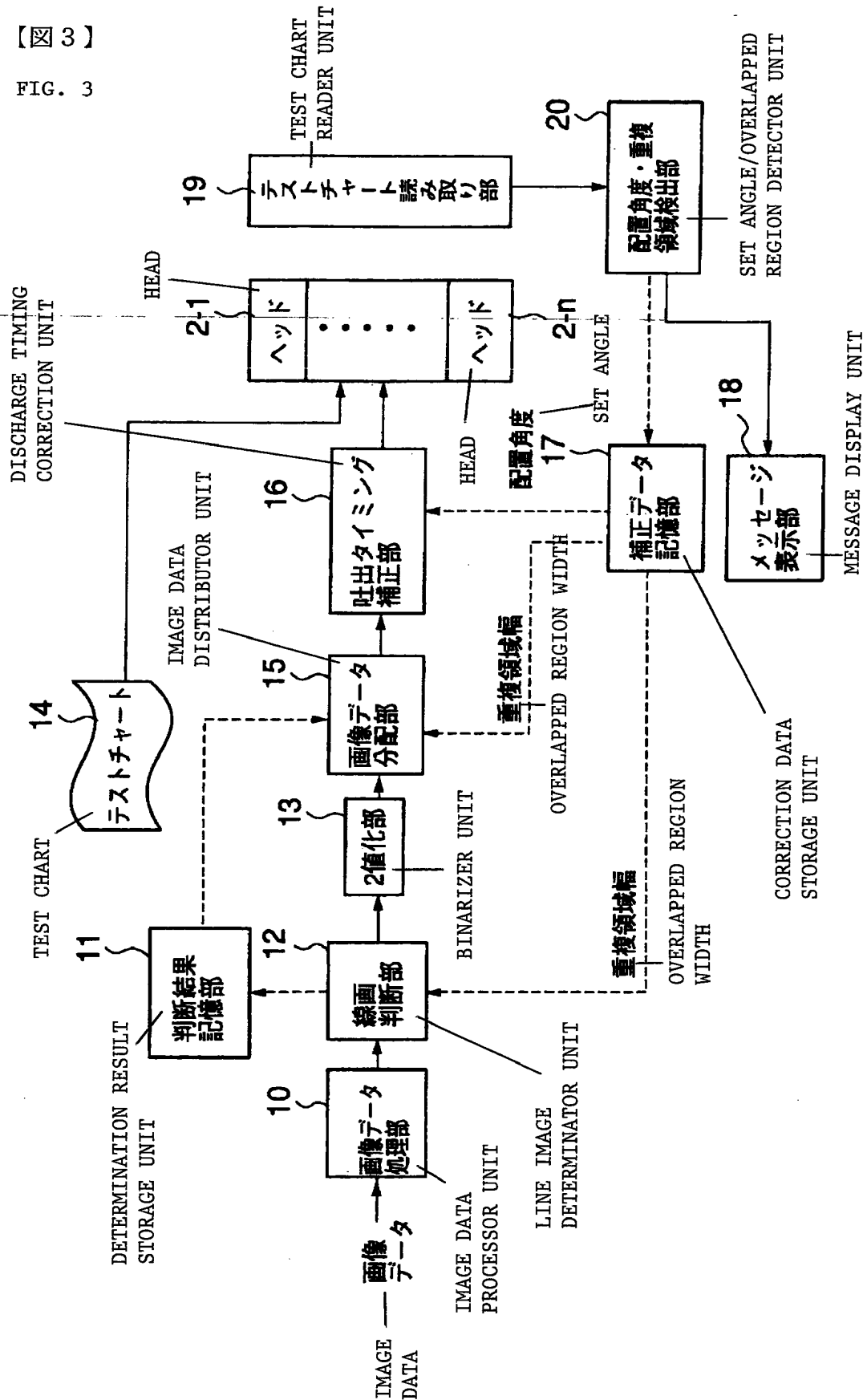
【図 2】

FIG. 2



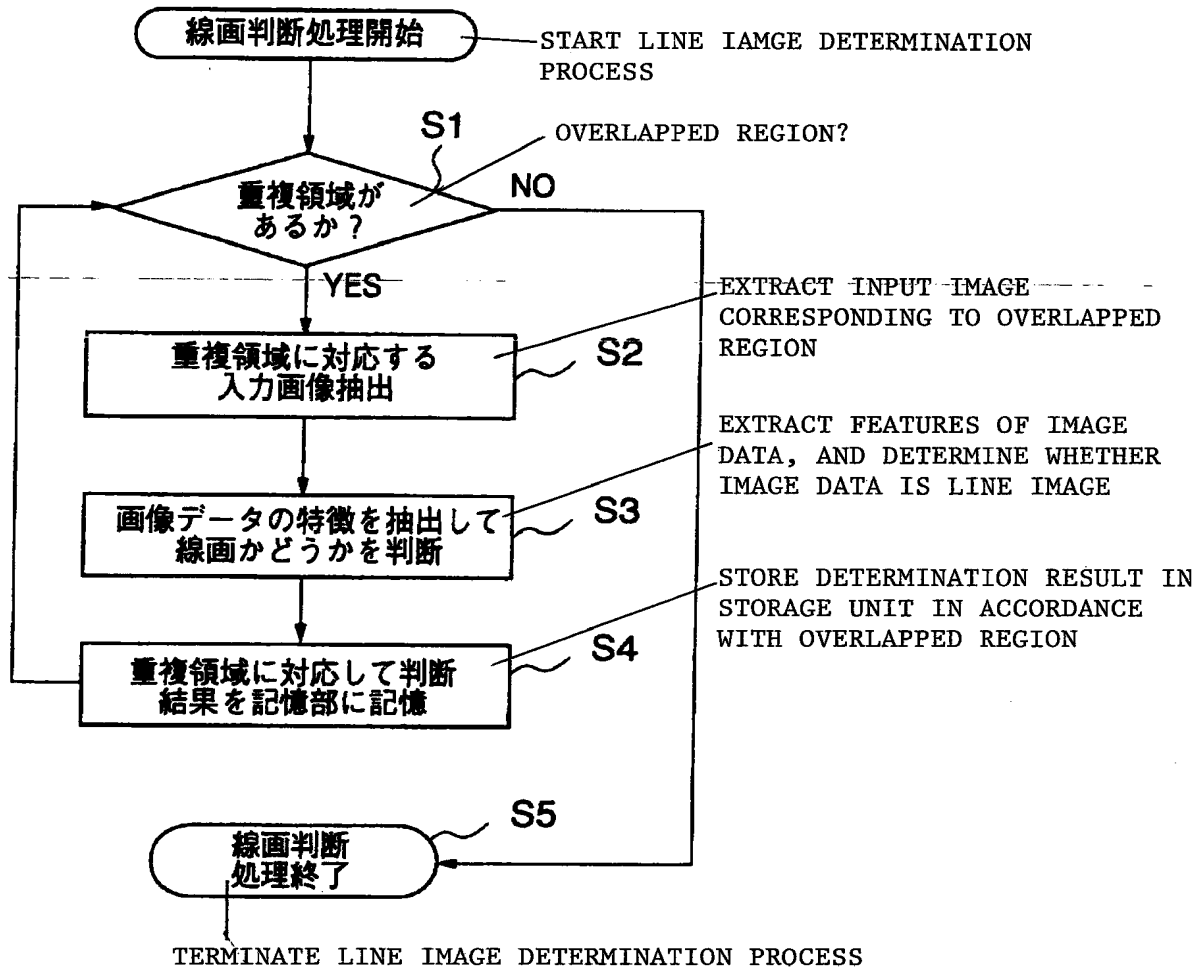
【図 3】

FIG. 3



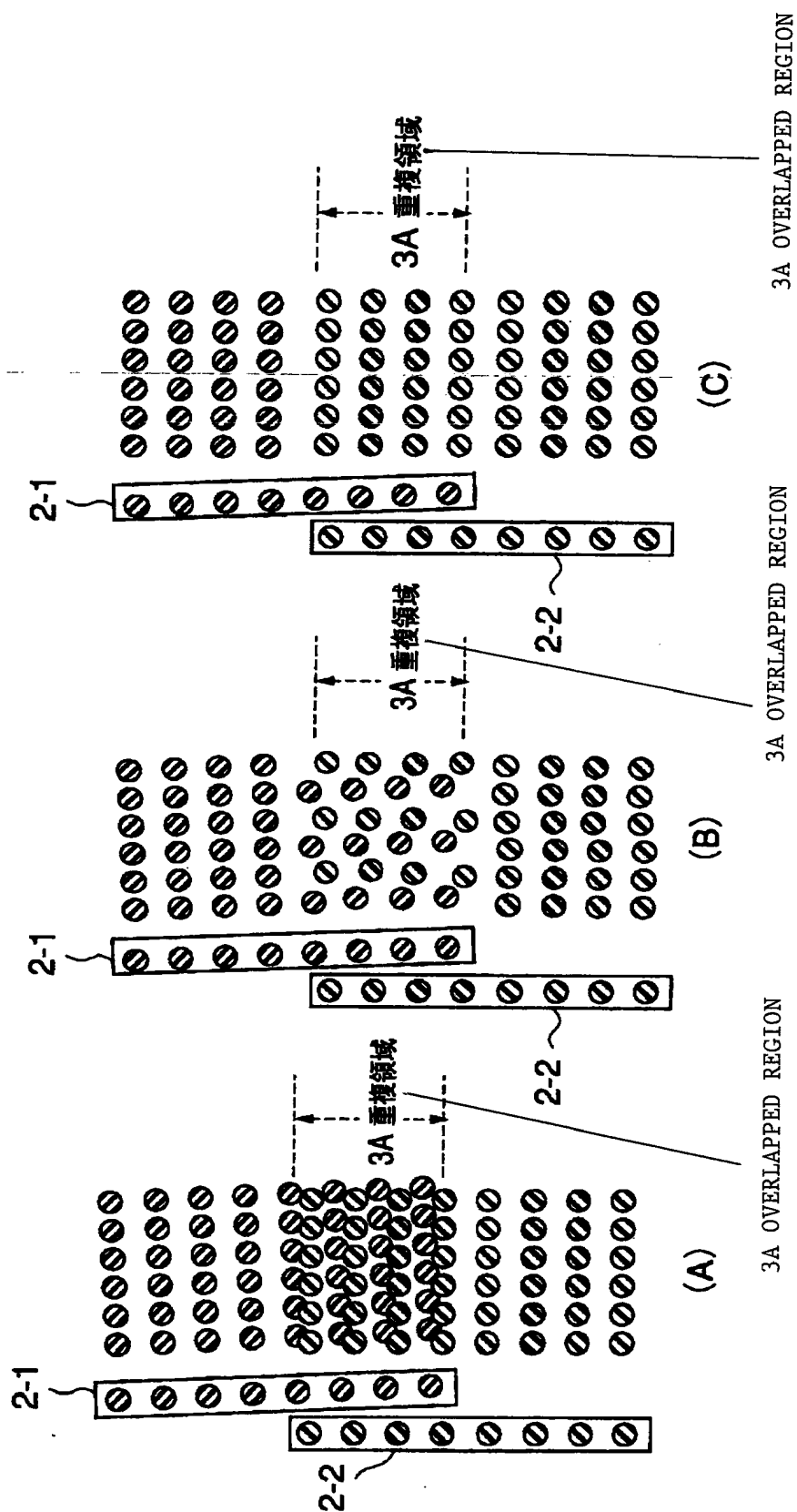
【図4】

FIG. 4



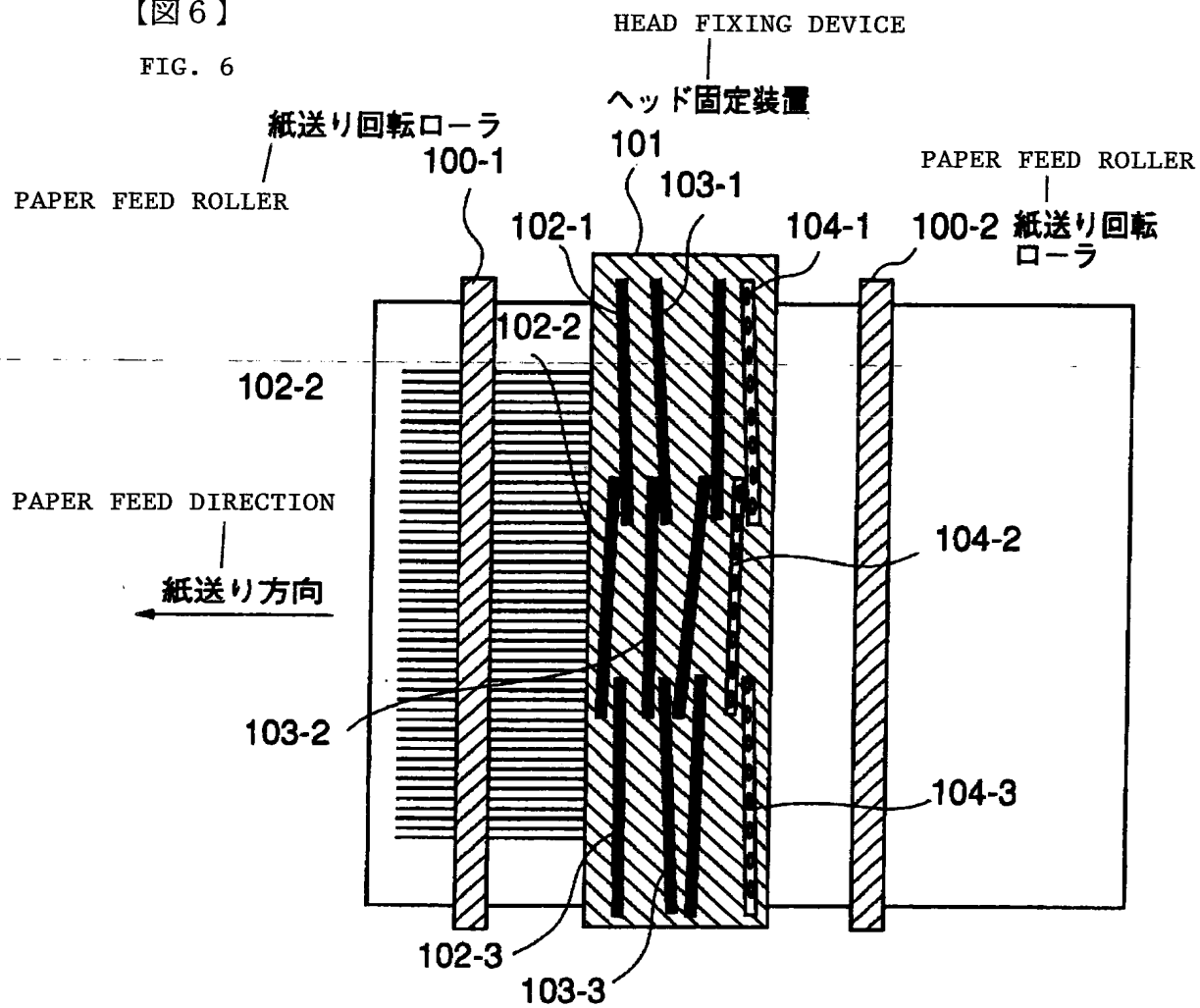
【図 5】

FIG. 5



【図 6】

FIG. 6



[Document] ABSTRACT

[Abstract]

[Object] To provide an image forming apparatus capable of eliminating density unevenness in the head overlapped regions only by rough head alignment.

[Means for Achieving the Object] An image forming apparatus includes recording head units 2-1 to 2-n in which a plurality of recording heads are arranged in substantially the same direction as an arranging direction of nozzles such that an overlapped region is formed between the heads; a set angle/overlapped region detector unit 20 for detecting a set angle and a width of the overlapped region of each of the plurality of recording heads from a predetermined test chart printed using the recording head units 2-1 to 2-n; an image data distributor unit 15 for distributing image data input to each of the plurality of recording heads, in accordance with the detected width of the overlapped region between the heads; and a discharge timing correction unit 16 for, when driving the nozzles of each of the plurality of recording heads in accordance with the distributed image data, correcting a discharge timing of each nozzle in accordance with the detected set angle.

[Elected Figure] FIG. 3